Original Research Article

Study on the relationship and mechanism between community environment and residents' happiness : A case study of Haikou city

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Abstract: This study employs a generalized structural equation model (GSEM) with Baidu Street View data to examine the relationship between community environment and residents' happiness, focusing on the mediating role of subjective environmental perceptions. Results show: 1)Direct Effects: Both objective community environment indicators (safety facilities, street vitality, green coverage, motor vehicle traffic) and subjective perceived walkability directly correlate with residents' well-being. Safety, vitality, greenery, and traffic show positive associations, while road proportion negatively impacts well-being. Among subjective factors, only perceived walkability directly enhances happiness, with perceived safety boosting walkability and perceived air pollution reducing it. 2)Mediating Pathways: Perceived walkability mediates the relationship between objective environmental factors (building proportion, vitality, greenery) and happiness, accounting for 52.26% of the total effect. "Perceived security → walkability" and "perceived air pollution → walkability" further mediate links between street vitality/air pollution and happiness. The findings reveal how Haikou's community environment influences happiness through both objective conditions and subjective experiences, offering insights for constructing livable cities and improving residents' well-being.

Keywords: Community environment; Green equity; Residents' happiness index; Structural equation modeling

1. Introduction

The community environment, as a pivotal public space for residents[1], significantly influences well-being by shaping emotional and social interactions. While prior studies highlight factors like greening, safety, and walkability as mental health determinants, they lack comprehensive analysis of how these factors interact through objective conditions and subjective perceptions, and their causal pathways remain under-explored[2-7].

Current community environment assessments often rely on overhead data (e. g., remote sensing), which fail to reflect residents' eye-level experiences—critical for understanding true environmental perceptions. Street view data, combined with deep learning models like DeepLabv3+[4-6,9], offers a more resident-centric approach by accurately segmenting environmental features (e. g., greenery, traffic) at human scale, addressing limitations in traditional method[s][9].

Structural Equation Modeling (SEM) is used here to examine complex relationships between community design elements (e. g., green spaces, traffic) and happiness, focusing on mediating effects of perceived safety, walkability, and air quality. This study aims to bridge two research gaps: 1) The heterogeneity between objective environmental metrics and residents' subjective perceptions; 2) The causal pathways through which community environments influence happiness. By integrating street view data, SEM, and stratified analysis of health status and socioeconomic factors, the research deepens understanding of how urban environments shape well-being in Haikou.

2. Research overview and data

The travel data originates from the "Health Survey of Community Green Spaces/Residential Areas" conducted in Haikou City from November to December 2022. Using stratified proportional sampling, 21 communities and 2 towns were selected across Haikou's urban districts. Within each community, 30–40 residents were randomly intercepted for the survey, which covered sociodemographics, exercise habits, psychological well-being, and community details. Of 709 collected questionnaires, 690 were valid, yielding a 97% response rate.

Respondents' home addresses were used to geocode residential and nearby park coordinates. A 500m circular buffer zone was created around each coordinate to extract street environmental and built environment metrics. To ensure robustness, 800m and 1000m buffer zones were also analyzed to test for result consistency.

3. Quantification of community built environment elements

3.1. Variable selection

The dependent variable, measuring residents' happiness, is the WHO-5[10] Well-Being Index. It's a 5-item scale (0–25 points) assessing mental health over two weeks. With a Cronbach's alpha of 0.815, it reliably measures well-being related to the community environment[11].

Independent variables come from Baidu Maps streetscape images[12] in Haikou. Sampling points on OpenStreetMap road networks capture 4-angle images, processed by the DeepLabv3+ model. Five built environment metrics are extracted: greening, street vitality, motor vehicle traffic, safety facilities, and view openness.

Mediating variables, including perceived safety, walkability, and air pollution, are measured by 5-point Likert scales. Higher scores mean better environmental evaluation, affecting overall happiness.

Covariates consist of street-level densities and individual factors, controlling confounding effects for relationship analysis.

3.2. Research framework and model

The research framework (**Figure 1**) combines five objective community environment indicators with three subjective perception indicators to study their impacts on residents' happiness.

Descriptive analysis is done first, followed by applying a generalized structural equation model (GSEM) with a logit function. A single-level GSEM is used due to limited sample coverage. STATA 14.0 tools are used for calculations and tests.

Four models are set up: Model 1 studies residential environment indicators vs. happiness; Model 2 creates a composite indicator; Models 3–4 stratify respondents by functional disease status to control self-selection bias, evaluating links between built environment, perceptions, and happiness considering health-related confounders.

4. Results analysis

4.1. Descriptive statistics

Descriptive analysis shows no significant differences in community safety facilities, street vitality, or motor vehicle traffic between residential and park areas. Road occupancy rates are 0.11 (residences) and 0.13 (parks), with greening at 0.23 and 0.25, respectively. Perceived safety (2.92 vs. 3.08), walkability (3.87 vs. 4.01), and air pollution (2.36 vs. 2.48) also show slight park-area advantages.

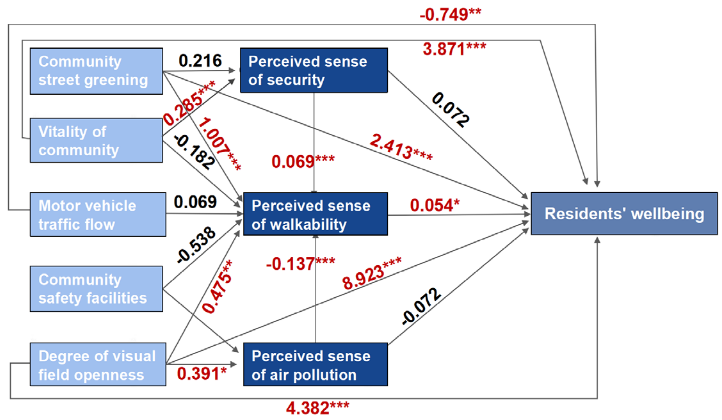

Figure 1. Path diagram of environmental exposure around residential areas and park green space (Models 1 and 2), significance level : *p<0.10,**p<0.05,***p<0.01, all covariables were adjusted).

Street greening, slightly higher near parks, significantly impacts residents' mental health and happiness(see **Figure 1**). Higher vegetation coverage enhances visual appeal, improves air quality, and reduces noise, directly elevating quality of life and well-being.

4.2. Model Results Analysis

Model testing confirmed no multicollinearity, with Model 1/2 comparisons showing significant direct links between integrated built environment, perceived environment, and happiness. All five objective indicators directly impacted happiness: safety facilities correlated positively (supporting "eyes on the street" theory via enhanced pedestrian safety)[13], vibrant streets boosted happiness, and greening improved well-being through ecological benefits like air quality and stress reduction[14].

Notably, motor vehicle traffic positively associated with happiness (unlike prior research), possibly due to Haikou's short distances to green spaces, while road occupancy showed a significant negative correlation, likely from indistinct pedestrian/cycling path data. Among subjective indicators, perceived walkability directly increased happiness, with safety enhancing walkability and air pollution reducing it, highlighting the interplay between objective conditions and perceptions.

Stratified analysis revealed safety facilities and greening strongly boosted happiness for respondents without functional diseases, while road occupancy decreased their happiness. No such associations emerged for those with functional diseases, possibly because health-focused motivations overshadowed environmental impacts. Motor vehicle traffic influenced happiness through dual pathways: directly improving walkability but also reducing it via perceived pollution. These findings underscore the moderating role of health status in environmental effects on well-being.

5. Conclusions and discussion

This study uses a generalized structural equation model (GSEM) to analyze how urban community environments influence residents' happiness, with a focus on subjective environmental perceptions as mediating factors. Results show community environment indicators—including safety facilities, street vitality, greenery, and traffic—positively correlate with happiness, while road occupancy has a negative effect. Key mediating pathways involve perceived safety, walkability, and air pollution, with walkability most strongly linked to physical activity and safety reducing environmental stress.

A notable innovation is the SEM framework combined with DeepLabv3+ segmentation, which captures tropical community features like greenery and traffic at human scale. Environmental indicators show weak-to-moderate correlations, confirming SEM's ability to model distinct environmental impacts. Street greening and vitality strongly relate to safety perceptions, while view openness connects to air pollution perceptions, with transportation environments emerging as a critical mediating pathway for well-being.

Findings offer urban planning insights: integrating Baidu Street View and DeepLabv3+ enables large-scale, efficient community environment assessments. In dense urban centers, prioritizing pedestrian-friendly green spaces, safety infrastructure, and stakeholder collaboration can enhance livability. Limitations include reliance on subjective air pollution data, privacy constraints of street view imagery, and a small sample size, calling for future longitudinal studies to deepen understanding of green equity and environmental impacts on well-being.

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